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Sustainable economy development and transition of fuel and energy in Lithuania after integration into the European Union

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ABSTRACT

The article describes sustainable development of Lithuanian economy and transition of fuel and energy after the integration of Lithuania into the European Union (EU), covering the period 2004–2012. In 2004–2008 Lithuanian gross domestic product (GDP) increased approximately 1.8 times and Lithuania was one of the most rapidly developing countries in the EU. The average of the yearly growth rate of GDP was 7.1%. In 2008 GDP growth rate decreased to 2.9% whereas in 2009 – down to − 14.8% (the consequences of the global financial crisis). In 2009–2012 Lithuanian economy recovered and GDP reached the volume before the crisis. GDP per capita at current prices in the period 2004–2012 increased about twice from 18.3 to 37.5 thousands LTL (1 LTL=0.2896€). In Lithuania 70–80% of electricity in 2004–2009 was produced from Lithuanian Ignalina Nuclear Power Plant (INPP). The indigenous and renewable energy sources (RES) in 2009 comprised 14.7% of gross inland energy consumption. At the end of 2009 the Lithuanian INPP was closed for the usage of unsafe technologies and the structure of gross inland fuel and energy consumption changed radically. The sector of RES became the driving force of the country's economy.

In the analysis the growth rate and the index of GDP in Lithuania are shown. The composition and tendencies of changes of gross inland and the final energy consumption are highlighted. The share of the RES in gross inland energy consumption is indicated. Final fuel and energy consumption by different energy sources and various consumer groups is analysed. The indices of energy intensity and labour productivity in different spheres of economy are presented. The environmental pollution indicators, emissions of greenhouse gas and other air pollutants by all kinds of economic activities are analysed.

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Abbreviations: CHP, Combined Heat and Power; EC, European Commission; EFTA, European Free Trade Association; ENTSO-E, European Network of Transmission System Operators for Electricity; EU, European Union; GDP, Gross Domestic Product; GHG, Greenhouse Gas; GNI, Gross National Income; GVA, Gross Value Added; INPP, Ignalina Nuclear Power Plant; JSC, Joint-Stock Company; LEI, Lithuanian Energy Institute; LNG, Liquefied Natural Gas; LTL, Lithuanian Litas (1LTL=0.2896€); NPP, Nuclear Power Plant; PPS, Purchasing Power Standards; RES, Renewable Energy Sources; SU, Soviet Union; TOE, Tonnes of Oil Equivalent; USA, United States of America

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1. Introduction

1.1. Some history

After the collapse of the former Soviet Union (SU) in 1991, one of the main tasks of political and economic institutions of Lithuania was to stabilise the supply of energy to all consumers: industry, transport and households. Until 1990 Lithuania was fully integrated into the economy of the SU and the energy sector was oriented towards large but inefficient energy consumption as well as considerable export of electricity and petroleum products to neighbouring regions. Development of the power system was based on construction of large power plants such as Lithuanian Thermal Power Plant (with installed capacity of 1800 MW) fired by natural gas and heavy fuel oil and Ignalina Nuclear Power Plant (INPP) (3000 MW_{el}). These power plants were constructed taking into consideration not only internal needs, but also growing electricity demand in the large North–Western region of the former SU. Excess of capacities in the power system, as well as inappropriate management of the national economy and the energy sector were serious deficiencies on a way of integration of Lithuania into the European Union (EU) [1].

The formation of energy policy and strategy for the next 10 and 20 years has become a priority, but it was a very difficult task as conditions were changing rapidly in the country and abroad. A sharp reduction in energy demand occurred due to fundamental changes in the structure of the economy and the breakdown of economic relations with former partners followed by deep economic crisis. Thus, primary energy consumption of Lithuania, which in 1991 amounted to 17.5 million toe, has decreased to 8 million toe, i.e., more than twice. Electricity consumption and district heat supply decreased at about the same degree. Major energy installations in Lithuania encompass a few large thermal plants, a nuclear power plant, and a refinery designed not only for the needs of Lithuania, but to supply a significant proportion of its production to Lithuania's nearest neighbours, which after 1991 were in the same economic decline. The total capacity of the power plants exceeded domestic and export demand by almost three times [2].

Besides all these difficulties there comes the unexpected demand of the EU to develop a programme of rapid closure of the Ignalina NPP – the cheapest source of electricity throughout the region. The main argument for this demand was that nuclear power reactors are the same type as in the Chernobyl NPP and according to western experts cannot be considered safe. For Lithuania the most important political priority was entry into the EU and Lithuania agreed with the requirement that INPP should be closed within a predetermined period of time. The deadlines were set so that the first unit should be closed at the end of 2004 and the second – at the end of 2009 [3,4].

Major impact on energy policy in Lithuania had preparation for accession to the EU. It was necessary to harmonise the energy policy of Lithuania with EU policy and a number of binding directives. The analysis of all possible scenarios was carried out by the experts of the Lithuanian Energy Institute (LEI), starting from the 1999 Energy Strategy and updating the analysis on a new 2002 National Energy Strategy [5]. The fate of the INPP, the source of the cheapest electricity and which provided nearly 70–80% of the country electricity supply had a special impact on the future of the electricity sector in Lithuania. In order to prepare a more or less reliable and realistic strategy for the period after shutdown of INPP, it was necessary to conduct a thorough modelling of the most probable scenarios for the future development of the energy sector, taking into account the possible developments in international energy markets and actions and plans of Lithuania's neighbours. The tendencies of renewable energy usage and policy in Lithuania in 2001 were analysed by LEI specialists in [6]. The trends of Lithuanian economy development and analysis of fuel and energy consumption in 2000–2004 were analysed by authors of such article in Lithuanian Academy of Sciences journals “Energetika” [7,8].

1.2. The integration Lithuania into the EU

The Treaty of Accession of Lithuania and nine other countries (the Czech Republic, Cyprus, Estonia, Hungary, Latvia, Malta, Poland, Slovakia, and Slovenia) into the EU was signed in Athens on 16 April, 2003. A referendum on the accession to the EU in Lithuania was held on 10–11 May, 2003. The turnout was 63.4%, and 91.1% of those who participated in the referendum were in favour of the EU membership. Lithuania became an EU Member State on 1 May, 2004, along with the nine other states. The First European Parliament election in Lithuania was on 10–13 June, 2004. On 11 November, 2004, the Lithuanian Seimas ratified the EU Constitution – the first Parliament to do so among the Member States. On 21 December, 2007, Lithuania with other 8 countries joined Schengen Area, on this day the internal land and sea border control was abolished. The air border control was removed on the 31st of March.

The new analysis of all possible sustainable development scenarios was carried out by experts of LEI on National Energy Strategy 2007 [9]. The most important strategic objectives outlined in such strategy were (1) energy security; (2) efficient use of energy; (3) introduction of competitive principles in the energy sector; (4) gradual integration into the energy systems of the European Union; (5) diversification of primary energy sources and ways of their imports, the rapid increase of renewable and local energy resources, and reducing the share of natural gas in the energy mix in Lithuania.

In order to achieve these objectives, the most important activities identified in such strategy were (1) implement the EU directives on the liberalisation of electricity and natural gas markets; (2) create a common electricity market of the Baltic countries and continue to integrate with the EU markets; (3) ensure continuity in the use of nuclear energy by building a new nuclear power plant capable of ensuring the needs of all three Baltic States and the region; (4) connect the electrical transmission network of Lithuania with the networks of the Nordic countries and Poland; (5) ensure compliance with the EU directives related to the accumulation of reserves of oil and natural gas; (6) increase the share of renewables in the primary energy balance up to 20% and the share of electricity produced at cogeneration power plants

up to 35% by 2025; (7) continuously improve the consumption efficiency of all types of energy, so that by 2025 it would be possible to achieve the efficiency levels of the developed countries of the EU.

Lithuania has agreed in the Accession Treaty on further increase of green energy in the energy balance and in particular the country has specific target related with the implementation of the Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from RES and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC [10]. Such Directive on the promotion of the use of energy from RES sets the overall target to reach 20% renewable energy in gross final energy consumption in 2020. This target is bound with individual Member State targets. The Lithuanian today's target is to increase the share of renewables in gross final energy consumption to 23% until 2020.

The coming sustainable energy transition in the world, its history, strategies and outlook were overviewed by USA specialists in Ref. [11]. The long run transitions to sustainable economic structures in EU and beyond was disclosed in Ref. [12]. A survey and review of approaches to study transitions is provided in Ref. [13]. The EU energy policy integration and the role and increased competence of the European Commission in the process of EU energy security policy development were analysed in Ref. [14]. The technical efficiency of economic systems of EU-15 countries from 1980 to 2008, based on energy consumption was studied in Ref. [15]. The interdependence of European–Russian energy relations were discussed in Ref. [16]. Energy relations between the EU and Russia by concepts of integration, liberalisation and diversification are examined in Ref. [17]. Natural gas supply stability and policy was discussed in Ref. [18]. The scenarios of EU 27 natural gas demand before 2020 and to 2030 were analysed in Ref. [19]. The assessment of the required share for a stable EU electricity supply until 2050 was made in Ref. [20]. The renewable energy and nuclear power towards sustainable development (characteristics and prospects) were thoroughly analysed in Ref. [21]. The Belgian nuclear power life extension and fuss about nuclear rents were discussed in Ref. [22]. The impact of the German nuclear phase-out on the Europe's electricity generation was studied in Ref. [23]. Long-term scenarios and strategies for the deployment of renewable energies in Germany were described in Ref. [24]. The indicative targets of the EU for electricity generation from RES in the Czech Republic were disclosed in details by Czech experts [25]. The costs and benefits of the renewable production of electricity in Spain are overviewed in Ref. [26]. The applications of RES in Greece are studied in Ref. [27]. The overview of challenges, prospects, environmental impacts and policies for renewable energy and sustainable development in Greece are outlined in Ref. [28]. The Romanian renewable energy sector was overviewed in Ref. [29]. Transition from traditional to sustainable energy development in the region of Western Balkans was examined in Ref. [30]. The renewable energies in Iran were overviewed in Ref. [31]. The policies to support the growth of RES of heat were overviewed in “Energy Policy” editorial paper [32]. The renewable heat incentive scheme in the United Kingdom was disclosed in Ref. [33]. The assessment of renewable electricity generation by pumped storage power plants in EU Member States was made in Ref. [34]. Article [35] evaluates the status of current RES deployment, policies and barriers in EU-27 member states and compares it to the required to meet the 2020 targets. The political feasibility of Norway as the ‘green battery’ of EU was analysed in Ref. [36]. The results of the impacts of climate change on the European energy system are presented in Ref. [37].

Promotional policy and perspectives of using renewable energy in Lithuania till 2005 were described by experts in Ref. [38]. Governmental policy and prospect in electricity production from renewables in Lithuania till 2008 were outlined by LEI specialists in Ref. [39]. Assessment of wood fuel use for energy generation in Lithuania was made in Ref. [40]. Comparative assessment of policies targeting energy use efficiency in Lithuania was made in article [41]. Promoting interactions between local climate change mitigation, sustainable energy development and rural development policies in Lithuania were analysed in Ref. [42]. The Greenhouse Gas (GHG) emission reduction potential in Lithuania and measures to promote household behavioural changes towards sustainable consumption was disclosed in Ref. [43]. The impact of international GHG trading regimes on penetration of new energy technologies and feasibility to implement EU Energy and Climate Package targets was studied in Ref. [44].

The sustainable Lithuanian economy development and changes of fuel and energy consumption in 2004–2008 were analysed by authors of such article in Lithuanian Academy of Sciences journals “Energetika” [45;46] and could be interesting for other countries.

Lithuanian general strategic guidelines, objectives, and vision of energy sector are disclosed in National Energy Independence Strategy of 2012 [47].

2. Sustainable development of Lithuanian economy

The Gross Domestic Product (GDP) is one of the main indicators defining the level of economic development of a country and is defined as the final value of goods and services produced in the country over the certain period. Its rates of change and gross national income (GNI) are widely used for international comparisons and economic analysis. The information on EU international comparison results are given on Statistics Lithuania material [48].

After accession Lithuania to the EU economy development in 2004–2012 was variable. In 2004–2008 Lithuanian economy grew rapidly. GDP increased by 1.8 times – from 63 to 112.4 billion LTL (1LTL=0.2896€) at current prices (Fig. 1) and Lithuania was one of the most rapidly developing countries in the EU. The yearly growth rate of GDP in 2004–2008 was on the range 2.9–9.8% (average of growth rate − 7.1%). The most rapid growth rate was achieved in 2007 and reached 9.8% (Fig. 2). In 2008 GDP growth rate considerably decreased and was only 2.9% [49,50].

In 2009 Lithuanian economy declined significantly, GDP growth rate in comparison to the previous year decreased to −14.8%. Such declination was the consequences of the global 2008 financial crisis and upcoming economical difficulties for the country. Despite of such GDP declinations, GDP indices in 2008 reached 177% (chain linked volume) in comparison to 2000 (GDP indices were 135% in 2004 and 172% in 2007).

As the consequences of the financial crisis, in 2009 such indices for GDP were only 151% and in 2010 – 153% in comparison to 2000 and were near the percentage average of 2005–2006. In 2010 were feeling the mending of Lithuanian economy, GDP increased by 1.5%, as compared to 2009. In 2011 and 2012 GDP growth rates were 5.9% and 3.6% respectively which showed the revival of Lithuanian economy after the crisis. From 2009 to 2012 Lithuanian GDP increased from 92 to 112.4 billion LTL (at current prices) and reached the volume before the crisis.

GDP per capita at current prices in 2004 in Lithuania was 18.3 thousand LTL and over the period to 2008 (period before the financial crisis) increased about 1.8 times to 33.4 thousands LTL. That amounted around 61% of EU average by purchasing power standards (PPS). GDP per capita in PPS for 2000, 2004 and 2011 years in Lithuania and EU-27 countries are shown in Fig. 3 [51].

The volume index of GDP per capita in PPS is expressed in relation to the EU-27 average set to equal 100. The basic figures are expressed in PPS, i.e. a common currency that eliminates the

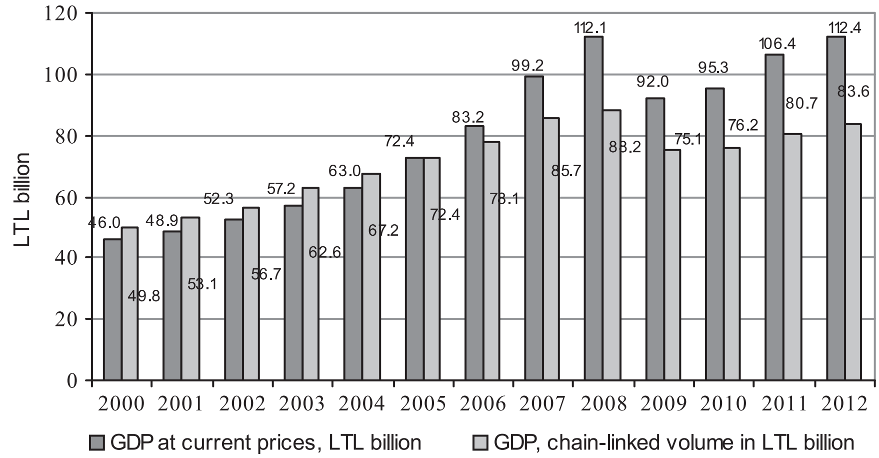


Fig. 1. Lithuanian gross domestic product (GDP) for the period 2000–2012.

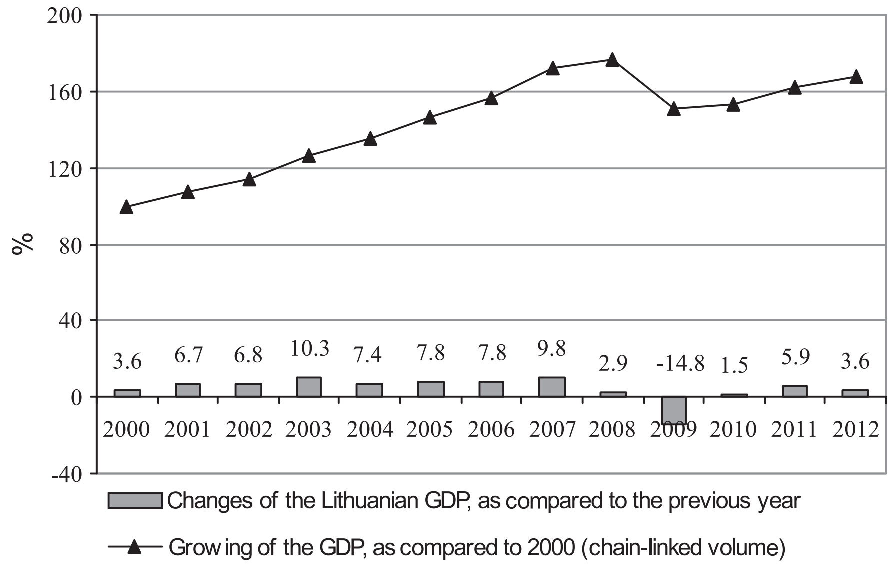


Fig. 2. Growing of the Lithuanian GDP and its index.

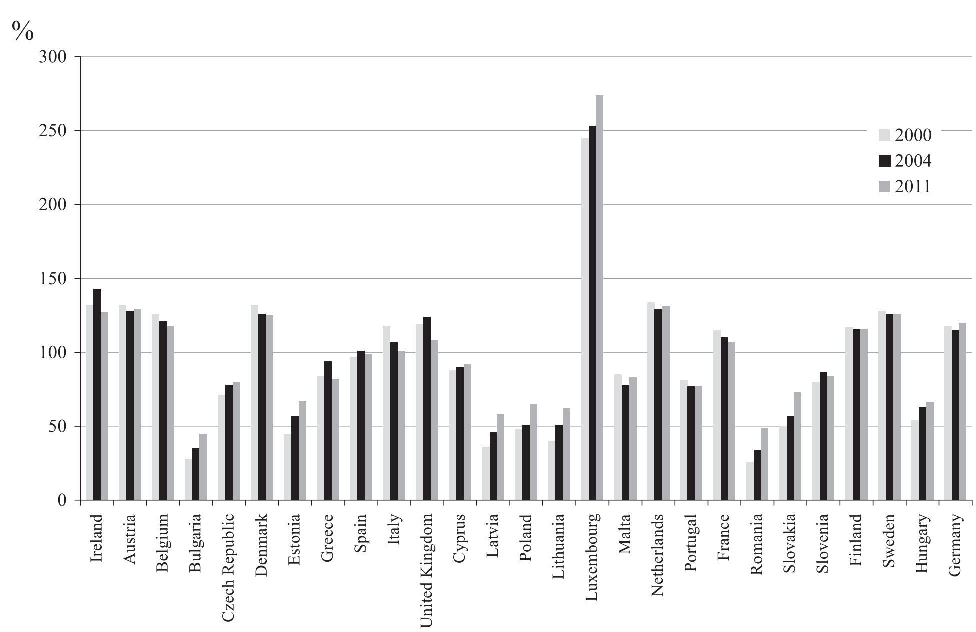


Fig. 3. GDP per capita in PPS for 2000, 2004 and 2011 years in Lithuania and EU-27 countries (EU-27 = 100).

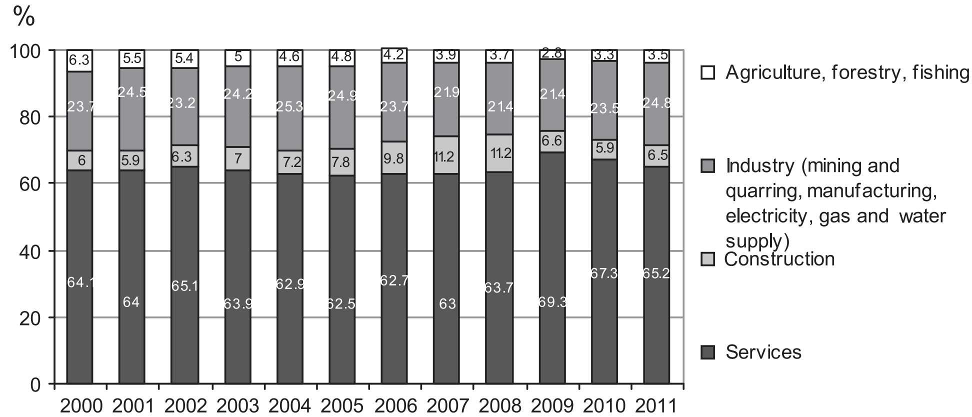


Fig. 4. Structure of gross value added by economic activity in 2000–2011 in Lithuania.

differences in price levels between countries allowing meaningful volume comparisons of GDP between countries.

At the pick of Lithuanian economy recession in 2009 GDP per capita was reduced to 27.5 thousands LTL and amounted only 55% of EU-27 average. From 2009 to 2011 Lithuanian economy slowly recovered. In 2011, GDP per capita reached 35.1 thousands LTL [52,53], which was by 7.5 thousands LTL higher than in 2009 and exceeded the GDP level before the crisis (33.4 thousands LTL). In 2011 GDP per capita in PPS amounted 66% of the EU average and exceeded the respective indicators of Latvia, Romania, and Bulgaria.

The most favourable economic situation in 2011 was observed in Luxemburg (271% of the EU-27 average, Fig. 3). One of the main reasons was a big amount of people coming everyday to work in Luxemburg from other countries. They were creating the GDP, however, GDP per capita were calculated (as were determined) by the regular country inhabitants. In the Netherlands, Ireland, Austria and Sweden GDP per capita were also high and exceeded the EU average in 1.3 times. Among the new EU member states, the best-developed economies were in Cyprus (94%), Slovenia (84%), Malta (85%), and Czech Republic (80% of the EU-27 average). The worst economic situation was in Bulgaria (46%) and Romania (49% of the EU-27 average).

The EFTA (European Free Trade Association) countries Norway and Switzerland exceeded the EU average in 1.9 and 1.6 times accordingly (not shown in Fig. 3).

In Lithuania increasing the GDP per capita in PPS (2004 – 10%, 2005 – 11%, 2006 – 13%, 2007 – 21%, 2008 – 5%, 2010 – 10%, 2011 – 11%) every year stimulated the growing of consumption expenditures.

According to the kinds of economic activity, the main part (62.5–69.3%) of gross value added in 2004–2011 in Lithuania depended on services sector (Fig. 4).

The part of gross value added of industrial sector (mining and quarrying, manufacturing, electricity, gas and water supply) for the period 2000–2011 was in the range 21.4–25.3%. From 2004 to 2009 the part of gross value added on industrial sector in Lithuania gradually decreased from 25.3% to 21.4% and to 2011 year – increased to 24.8%.

From the middle of 2008 the decreasing of all Lithuanian economy sectors was felt mainly due to the influence of the global financial crisis and the unbalanced economical equilibrium in immovable property and construction markets. The changes of demand greatly influenced the Lithuanian industrial and commercial development, decreased the processes of investments, mainly for the downfall of the leading foreign trade markets and decreased the Lithuanian commodity and services demand.

3. Transition of gross inland fuel and energy in Lithuania

Gross inland fuel and energy consumption in Lithuania for the period 2004–2011 changed in the range 295–392 PJ. The peak of consumptions was in 2007 (391.6 PJ) and the bottom in 2010 (295.3 PJ) [54–57].

3.1. Gross inland fuel and energy consumption

For the Lithuanian needs imported and indigenous energy resources were used . Before 2010 the Lithuanian gross inland consumption consisted of the nuclear energy, hydropower, oil products, natural gas, wood, coal and other fuel. About third of gross inland fuel and energy consumption comprised nuclear energy.

Lithuania has limited quantity of indigenous energy sources and was depended from import of energy resources (natural gas, petroleum, hard coal). In 2009 Lithuanian energy dependence from such resources comprised approximately 48.9%. The prices of imported organic fuel continually raised and constantly increased the consumption of indigenous and renewable energy sources. The distribution of gross inland fuel and energy consumption in Lithuania for the period 2004–2011 is shown in Fig. 5.

From 2004 to 2008 the consumption of oil products in Lithuania increased from 105 to 124 PJ (about 1.2 times). In 2009–2011 the consumption of oil products decreased to 102–104 PJ (the level of consumptions as in 2004). Such indices depended basically from the import of oil products.

The consumption of natural gas from 2004 to 2008 increased from 98 to 109 PJ, i.e. on about 10%. In 2011 the consumption of natural gas reached 114 PJ.

In 2009 the most part, 29.7% of gross inland consumption depended on nuclear energy, the next was crude oil and petroleum products −28.7% and natural gas −25.1%. Renewable and indigenous energy sources consisted 14.7% of gross inland energy consumption.

At the end of 2009, according to the requirements of EU, due to the usage of unsafe technologies, the Lithuanian Ignalina NPP was closed. The structure of gross inland fuel and energy consumption in Lithuania changed radically. In 2010 the largest portion of gross inland fuel and energy consumption was comprised of petroleum products (36.2%) and natural gas (35.4%). The changes of gross inland fuel and energy consumption in Lithuania in 2009 and 2010 years are shown in Fig. 6.

Changes of gross inland energy consumption depended mainly from the energy produced by Ignalina nuclear power plant, because the biggest part 70–80% of electricity in Lithuania in 2004–2009 was produced from nuclear power. From 2009 Lithuania's energy dependence on the imports of fossil fuel remarkably

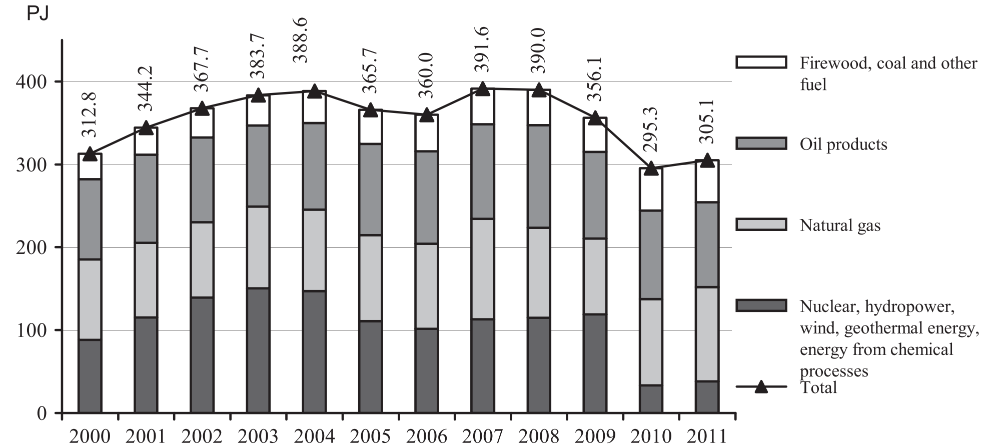


Fig. 5. Gross inland fuel and energy consumption in Lithuania for the period 2000–2011.

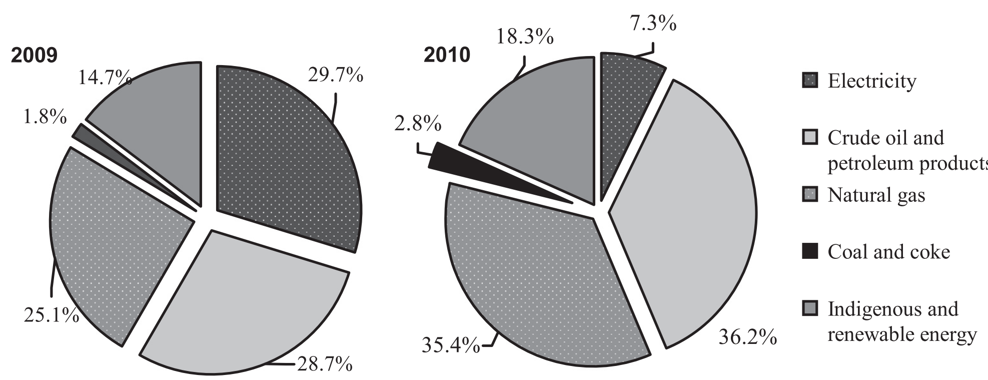


Fig. 6. Changes of gross inland fuel and energy consumption in 2009 and 2010 years.

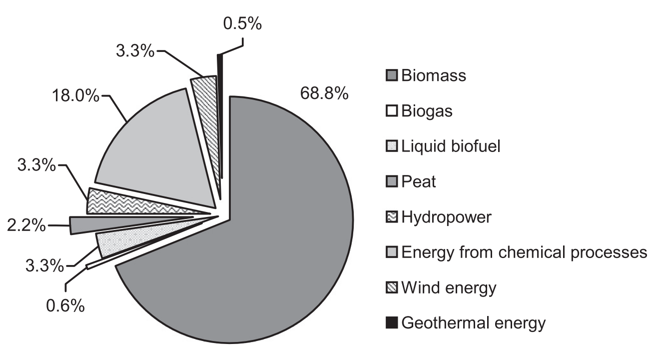


Fig. 7. Composition of renewable and indigenous energy consumption in 2011.

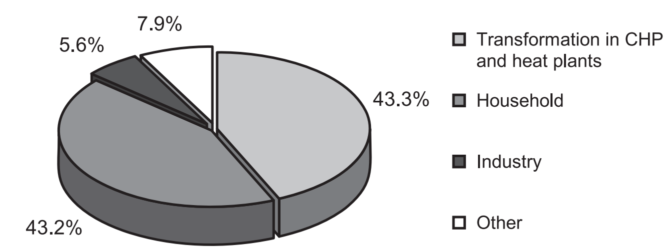


Fig. 8. Distribution of the renewable and indigenous energy by economy sectors in Lithuania in 2011.

increased – from 50% in 2009 to 82% in 2010–2011, and considerably exceeded the EU average 53% [58].

In 2011 the distribution of gross inland fuel and energy consumption in Lithuania were similar as in 2010 and were electricity – 7.9%, crude oil and petroleum products – 33.6%, natural gas – 37.3%, coal and coke – 2.9%, indigenous and renewable energy – 18.3%.

3.2. Renewable and indigenous energy sources

The composition of renewable and indigenous energy sources in gross inland consumption in Lithuania in 2011 are shown in Fig. 7 [57].

The main share 68.8% of such resources depends on biomass. Energy from chemical processes consisted of 18%, liquid biofuel – 3.3%, hydro-energy – 3.3%, wind energy – 3.3% and other sources – 3.3%.

Distribution of renewable and indigenous energy sources by economy sectors in Lithuania are shown in Fig. 8. In 2011 about 43.3% of such resources were transformed in Combined Heat and Power (CHP) and heat plants, 43.2% – consumed in households, 5.6% – in industry and 7.9% – in other sectors.

In order to diminish the dependence on imported fuel and reduce the impact of fossil fuel on the environment, a wide use of RES is of great importance. A wider use of RES in electricity and heat production and transport enables to reduce the consumption of imported fossil fuel, especially natural gas and petroleum products. Over recent years, the consumption of RES in Lithuania has changed significantly. In 2011, firewood, wood and agricultural waste accounted for 86.5% of the total consumption of renewable energy sources, biofuel – 4.4%, hydropower – 3.9%, wind energy – 3.9%, biogas – 1.0%, geothermal energy – 0.3% (Fig. 9).

Today the greatest RES potential in Lithuania is shown by biomass, especially firewood and wood waste.

According to the statistics of Lithuania, at the end of 2009 energy from renewable energy sources produced 119 power stations: 3 biomass, 5 biogas power, 86 hydropower and 25 wind

power stations. Wind farms are one of the most environment-friendly and rapidly developing renewable energy technologies in Lithuania, which started to produce electricity from 2004. In 2009 the energy produced from wind power in Lithuania comprised 1% (0.57 PJ) of all produced electricity, in 2010 – about 3.9% (0.81 PJ). From 2010 to 2011 electricity production on wind farms increased 2.1 times (to 1.71 PJ) and accounted for 9.9% of the total electricity production in the country.

The share of RES in the total energy consumption in Lithuania for the period 2004–2011 increased from 8.0% to 14.5% (Table 1) [59,60]. The share of electricity from RES in the total energy production for the period 2004–2009 increased from 2.2% to 4.5% and for the period 2009–2011 – from 4.5% to 23.1%.

Biofuel production and consumption in Lithuania are regulated by international obligations related to reduction in greenhouse gas emissions and increase in biofuel use in transport. The main types of biofuel consumed in Lithuania are biodiesel and bioethanol, which were started to be produced from 2004. The share of biofuel in road transport fuel consumption increased from 0.1% in 2004 to 4.4% in 2009 and in 2011 slightly decreased to 3.7%. In 2011 were consumed 14.6 thousand tonnes of bioethanol and 40.0 thousand tonnes of biodiesel in Lithuania.

4. The final fuel and energy consumption in Lithuania

After the integration into EU the final energy consumption in Lithuania from 2004 to 2007 increased 16.5% from 180 to 210 PJ. In 2008 and 2009 such consumption decreased respectively to 205 and 192 PJ (consequences of the global financial crisis) and in 2010–2011 – slightly increased to 197–200 PJ (Fig. 10).

About the third share of final consumptions in 2004–2011 depended on oil products, which varied in the range 63–80 PJ. Heat energy consumption changed in the range 36–40 PJ, electricity consumption – 27–33 PJ, natural gas – 20–24 PJ. Firewood, coal and other fuels consisted of 32–40 PJ or 18–20% of final fuel and energy consumption.

In 2011 oil products comprised 34.1%, heat – 18.5%, electricity – 15.7%, natural gas – 11.3%, firewood and other fuels – 15.5% of final fuel and energy consumption. Distribution of final consumption by energy sources in 2011 in Fig. 11.

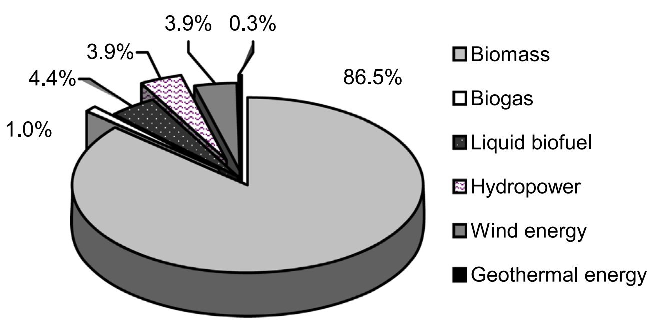


Fig. 9. Renewable energy consumption distribution in Lithuania in 2011.

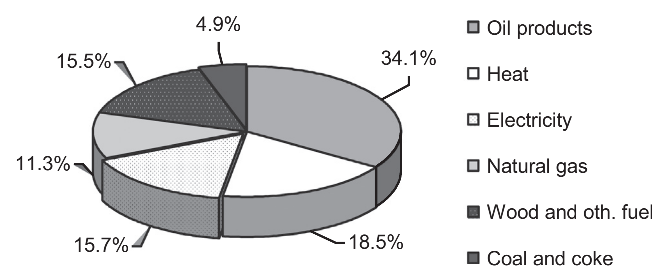


Fig. 11. Distribution of final fuel and energy consumption by energy sources in Lithuania in 2011.

Table 1
The share of RES in the total energy consumption in Lithuania, (%).

Renewable energy resources	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Share of renewable resources in the total energy consumption	9.4	8.3	8.0	7.7	8.0	10.0	10.7	10.2	10.7	12.1	15.1	14.5
Share of electricity produced from renewable resources in the total energy production	3.0	2.22	2.0	1.7	2.2	3.1	3.5	4.1	4.3	4.5	15.8	23.1
Share of biofuel in road transport fuel consumption	–	–	–	0.01	0.1	0.3	1.7	3.8	4.2	4.4	3.7	3.7

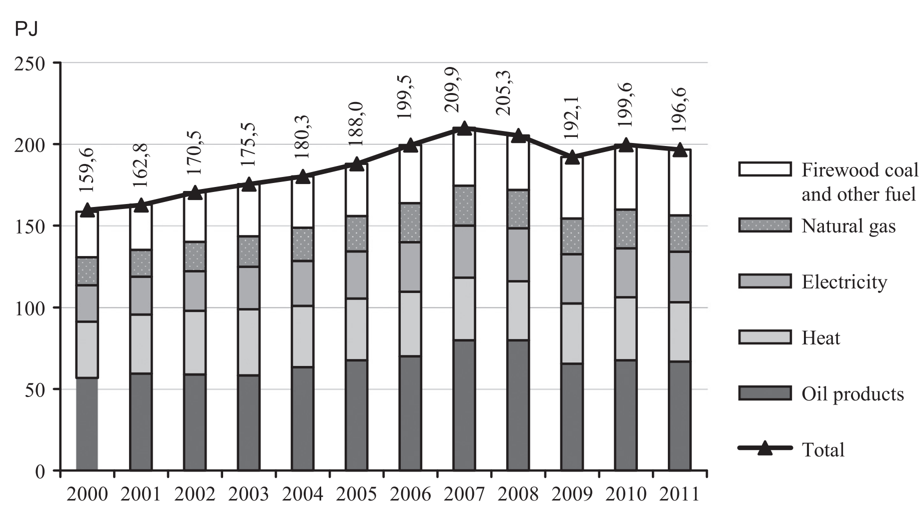


Fig. 10. Final fuel and energy final consumption by energy sources in Lithuania for the period 2000–2011.

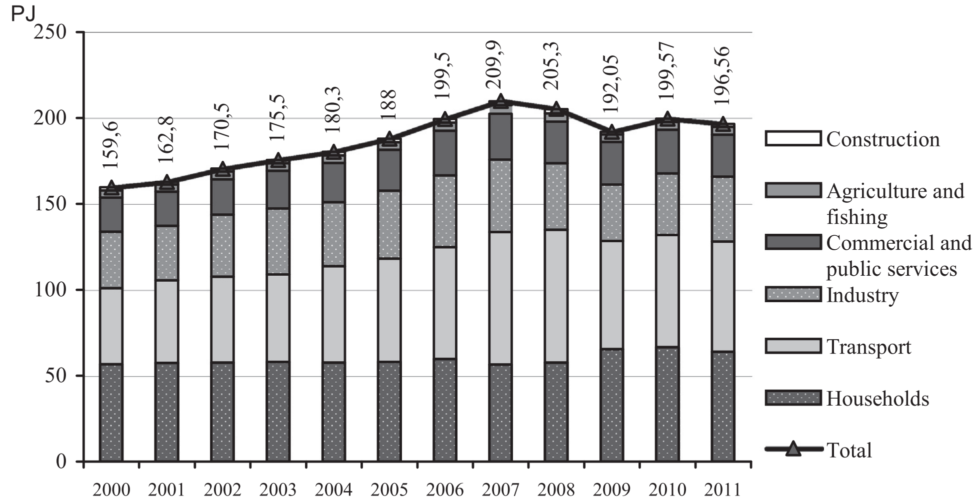


Fig. 12. Final fuel and energy final consumption by economy sectors in Lithuania in 2000–2011.

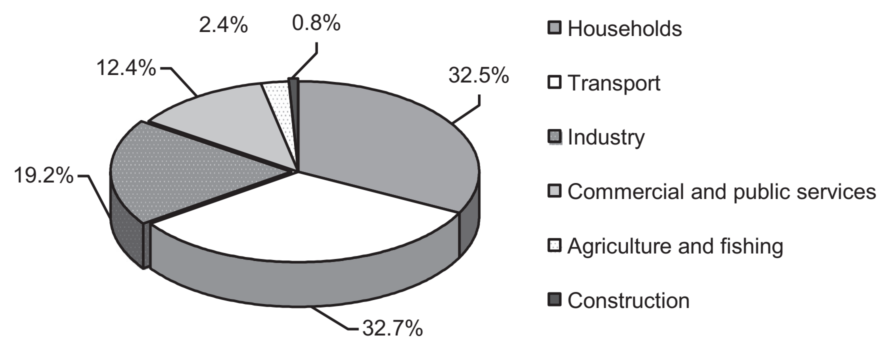


Fig. 13. Distribution of final energy consumption by economy sectors in Lithuania in 2011.

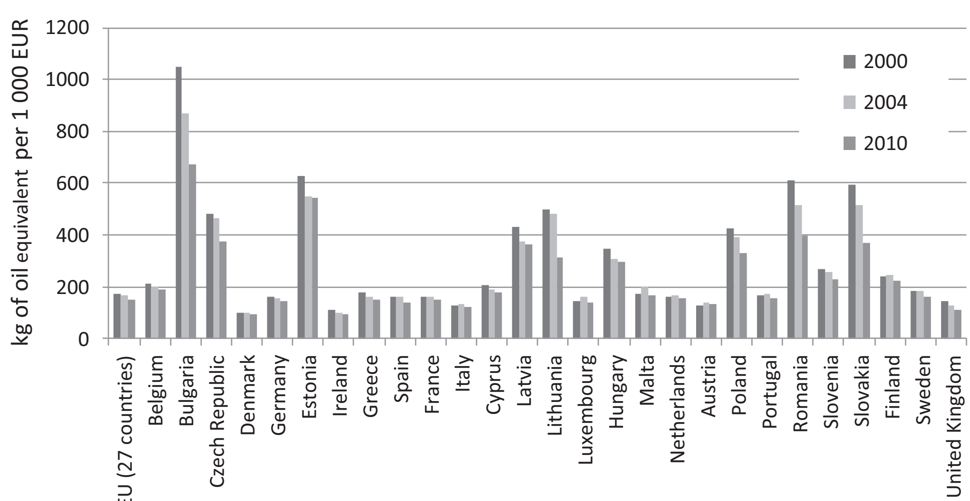


Fig. 14. Energy intensity of the economy in Lithuania and other EU-27 countries for the 2000, 2004 and 2010 years, (kg of oil equivalent per 1000 EUR).

Final fuel and energy consumption by economy sectors in Lithuania for the period 2004–2011 are shown in Fig. 12.

In household final fuel and energy consumption for the period 2004–2008 were more or less stable – 56–60 PJ and comprised 27–32% of all final consumption. In 2009–2011 final energy consumption in household increased to 64–67 PJ and comprised 32–34% of all final consumption. About 17–21% of final fuel and energy consumption (32–42 PJ) in 2004–2011 depended on industry. In 2009 fuel and energy consumption in industry decreased to 32 PJ, mainly for the global economic crisis.

Final fuel and energy consumption for transport sector in Lithuania in 2004–2008 increased by 38%, from 56.1 to 77.4 PJ, but in 2009–2010 – decreased by 16–19% to 63–65 PJ. In commercial and public services sector fuel and energy consumption for 2004–2011 in Lithuania were 23–27 PJ or about 12–13% of all final fuel and energy consumption and changed marginally. In 2011 about 32.7% of final energy consumption was consumed in transport, 32.5% – in households and 19.2% – in industry sectors. All other economy sectors together consumed 15.6% of final energy consumption (Fig. 13).

5. Energy intensity and labour productivity indicators

5.1. Energy intensity indicators

The comparison of energy intensity of Lithuanian economy and all EU-27 countries are given in Fig. 14 [61].

This indicator is the ratio between the gross inland consumption of energy and the GDP for a given calendar year. It measures the energy consumption of an economy and its overall energy efficiency. The gross inland consumption of energy is calculated as the sum of the gross inland consumption of five energy types: coal, electricity, oil, natural gas and renewable energy sources. The GDP figures are taken at chain linked volumes. The energy intensity ratio is determined by dividing the gross inland consumption by the GDP. Since gross inland consumption is measured in kgoe (kilogram of oil equivalent) and GDP in 1000 EUR, this ratio is measured in kgoe per 1000 EUR.

From 2004 to 2010 energy intensity of the Lithuanian economy decreased about 1.5 times, from 479 to 311 (kg of oil equivalent per 1000 EUR of GDP). On comparison, energy intensity of the economy (gross inland consumption of energy divided by GDP) in Bulgaria decreased 1.3 times from 870 to 671, in Romania – 1.3 times from 519 to 396, in Slovakia – 1.4 times from 515 to 371 (kg of oil equivalent per 1000 EUR). Energy intensity average of EU-27 countries during such period decreased only 1.1 times, from 167 to 152 (kg of oil equivalent per 1000 EUR).

The final energy intensity indicators by separate users groups in Lithuania for 2004–2010 years (ratio of final energy consumption in tonne of oil equivalent per LTL million of GDP) are shown in Table 2 [60].

The total energy intensity in Lithuania for the period 2004–2011 decreased about 1.2 times, from 70 to 58 TOE/LTL million of GDP. Energy intensity in industry during the period decreased also on 1.2 times (from 60 to 50 TOE/LTL million of GDP), in services sector – on 1.4 times (from 21 to 15 TOE/LTL million of GDP). Energy intensity in household and transport sectors decreased on 1.2 times, from 22 to 19 TOE/LTL million of GDP.

5.2. Labour productivity indicators

Labour productivity indicators of all Lithuanian economy for the period 2004–2011 increased nearly 1.7 times – from 22 to 36.7 GVA (Gross Value Added) per hour actually worked, LTL (Table 3) [60].

Labour productivity in Lithuania in manufacturing for the period 2004–2011 increased about twice, from 24.9 to 48.6 GVA per hour actually worked, LTL. In electricity, gas, steam and air conditioning supply economy sectors labour productivity for the recent 7 years increased 1.5 times (from 64 to 97.2 GVA per hour actually worked, LTL), in construction sector – 1.8 times (from 19 to 33.7 GVA per hour actually worked, LTL).

6. Environmental sustainable development indicators

Sustainable development is the development of the society providing opportunities to reach welfare for present and future generations by harmonising environmental, economic and social objectives of the society and without exceeding the allowable limits of the environmental impact [59].

The EU is an unquestioned leader in sustainable development of economy. The EU Strategy for Sustainable Development was approved by the European Council in Göteborg in 2001. It stated that sustainable development was a long-term EU strategy ensuring clean and healthy environment and better quality of life for the present and future generations. Implementing this strategy, it is necessary that the economic growth could accelerate the social progress and improve the state of the environment, that the social policy could stimulate the economic growth, and that the environmental policy could be effective from the economic point of view. A serious consideration in the strategy is given to the importance of decoupling the economic growth from resource consumption and the environmental impact. It means that with the economic growth, natural resource consumption and environmental pollution should be growing much slower than the economy or not growing at all.

In Lithuania, with the aim of ensuring the coordination of sustainable development process at the highest level, the National Commission on Sustainable Development under the Prime Minister's chairmanship was formed in 2000. The Lithuanian National Sustainable Development Strategy was approved by the Government on 11 September, 2003 [5]. The main long-term, mid-term and short-term objectives and tasks were formulated, and the most important implementation measures in various sectors and their branches were envisaged in the strategy.

Table 2
Final energy intensity in Lithuania by users groups for the period of 2000–2011 (TOE/LTL million GDP).[a]

Final energy intensity	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total	75.8	79.4	77.2	72.0	69.8	63.7	62.9	60.3	57.7	61.3	62.5	58.2
Industry	74.2	67.1	71.5	65.0	60.5	57.7	56.9	55.2	48.3	49.2	50.5	49.7
Agriculture	34.3	40.7	38.2	35.9	36.8	33.7	41.3	38.8	36.8	32.4	36.9	34.5
Household	27.5	28.1	26.4	24.0	22.3	20.9	20.2	17.6	17.7	20.9	20.9	18.9
Transport	21.,2	23.7	22.9	21.2	21.7	19.9	19.9	21.5	21.0	20.1	20.4	19.0
Services	18.3	21.4	20.9	20.8	20.5	16.3	16.7	15.9	14.8	16.2	16.6	15.3
Construction	16.4	14.6	14.9	12.8	12.3	9.8	8.2	6.8	6.9	8.2	9.7	7.7

[a] 1LTL=0.2896€.

Table 3
Labour productivity in Lithuania for the period of 2000–2010 (GVA per hour actual worked, LTL).[a]

Labour productivity	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total	**15.8**	**17.5**	**18.4**	**20.0**	**22.0**	**24.0**	**27.2**	**31.0**	**34.7**	**31.5**	**33.9**	**37.6**
Mining and quarrying	46.8	58.4	35.5	29.5	37.1	50.7	46.7	40.3	55.9	43.8	48.5	70.6
Manufacturing	16.8	18.6	17.8	20.1	24.9	26.7	28.7	30.6	33.9	33.0	40.7	48.6
Electricity, gas, steam and air conditioning supply	25.8	26.1	34.6	44.7	44.6	64.3	59.6	67.6	69.1	78.3	93.9	97.2
Construction	14.,8	15.5	16.5	17.7	18.7	19.9	25.0	30.5	34.8	23.9	28.1	33.7

[a] 1LTL=0.2896€.

In order to monitor the implementation of the strategy, a list of sustainable development indicators has been defined. These indicators directly link the objectives and tasks outlined in the strategy.

The renewed version of the Lithuanian National Sustainable Development Strategy was approved by Government Resolution of 16 September, 2009 [9]. Such version of the strategy had an updated list of sustainable development indicators.

6.1. Emissions of greenhouse gas

According to the data provided by the Lithuanian Ministry of Environment, the total emissions of greenhouse gas in 2000–2010 years in Lithuania ranged in 19,364–25,443 thousand tonnes of CO_2 equivalent (Table 4) [62]. Emissions of greenhouse gas in Lithuanian industry in such period ranged in 2249–6165 thousand tonnes of CO_2 equivalent, in energetics – in 4814–5777 thousand tonnes of CO_2 equivalent and in transport – in 3427–5418 thousand tonnes of CO_2 equivalent. In 2010 the emissions of greenhouse gas in energetics comprised 26.2%, industry – 10.8%, transport – 21.9% and other activities – 41.1% of total greenhouse gas emissions in Lithuania (Fig. 15).

In 2010 the total greenhouse gas emissions in Lithuania increased by 4.3% compared to 2009 and mainly in public electricity and heat production due to growing gas-based thermal power production. After the closure of Lithuanian Ignalina NPP in 2009 thermal power production based on natural gas is the most important source of electricity production in Lithuania. Emissions from road transport and other activities increased reflecting the gradual economic recovery after the strong decline in 2009.

The comparison of the emissions of greenhouse gas in Lithuania and all EU-27 countries for the base year 1990 and for 2004 and 2010 are shown in Fig. 16 [63].

Table 4
Emissions of greenhouse gas for the period 2000–2010 (CO_2 equivalent, thousand tonnes).

\Year	2000	2004	2005	2006	2007	2008	2009	2010
Total[a]	**19,364**	**21,840**	**22,919**	**23,314**	**25,443**	**24,331**	**19,959**	**20,810**
Industry	3031	3733	4096	4355	6165	5502	2302	2249
Energetics	5211	5521	5777	5326	4814	4897	4924	5446
Transport	3427	4129	4394	4656	5418	5375	4435	4565
Other activities	7694	8457	8651	8978	9047	8557	8298	8550

[a] Data provided by the Lithuanian Ministry of Environment.

The Lithuanian emissions are well below Germany, United Kingdom, France or Italy emissions and are comparable with Estonia, Slovenia, Latvia and Luxembourg greenhouse gas emissions. Greenhouse gas emissions index in Lithuania and EU-27 countries in 2010 and their percentage comparison with the base year 1990 are shown in Fig. 17 [64].

Such countries as Ireland, Greece, Spain, Portugal, Cyprus and Mata are exceeding the base year emissions more than 10%. The average of 2008–2010 emissions in Lithuania was 56.3% lower than the base year 1990 level (well below the Kyoto target of −8% for the period 2008–2012).

6.2. Emissions of air pollutants

Emissions of air pollutants (carbon monoxide, nitrogen oxides, sulphur dioxide, volatile organic compounds and particulate matters) by economic activities in Lithuania are shown in Fig. 18 [60].

From 2000 to 2010 years the total emissions of air pollutants of all economic activities in Lithuania decreased by 12% (from 446 to 391 thousand tonnes). The main part, 50.4% of such emissions in 2010 depended on energetics, 29.3% – on transport and 20.3% – on industry. From 2005 to 2009 in energy sector such emissions decreased by 24% (from 188 to 144 thousand tonnes) and in 2010 – increased by 37% to 197 thousand tonnes, mainly for the closure of Lithuanian INPP. In transport sector emissions of such air pollutants from 2007 to 2010 decreased on 33% from 163 to 110 thousand tonnes. In industry sector emissions increased by 10% from 72 to 79 thousand tonnes and always were about 1.5–2 times less than in energetics or transport.

Composition of such air pollutants in total emissions (all economic activities) in 2000–2010 in Lithuania are shown in Fig. 19.

In energetics and transport sectors 52–72% dominated carbon monoxide emissions and in industry 55–70% dominated volatile organic compounds.

7. The integration of Lithuanian energy sector in the EU in compliance with EU directives and policies

The main objectives of Lithuania in the energy sector (defined in the National Energy Independence Strategy [47]) is setting national targets for the implementation of strategic initiatives until 2020 and to lay down guidelines for the development of the energy sector until 2030 and until 2050, The **main goal** of this strategy **was to ensure Lithuania's energy independence before the year 2020 by strengthening Lithuanian's energy security and competitiveness**. Lithuania's energy independence will ensure an opportunity to

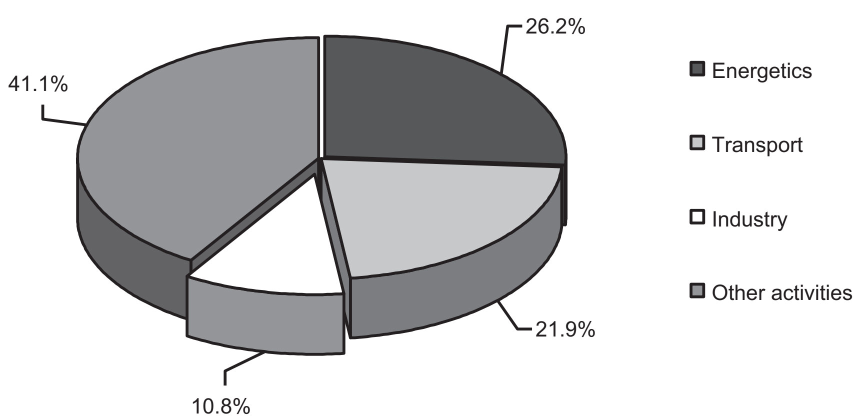


Fig. 15. Distribution of greenhouse gas emissions by economy sectors in Lithuania in 2010.

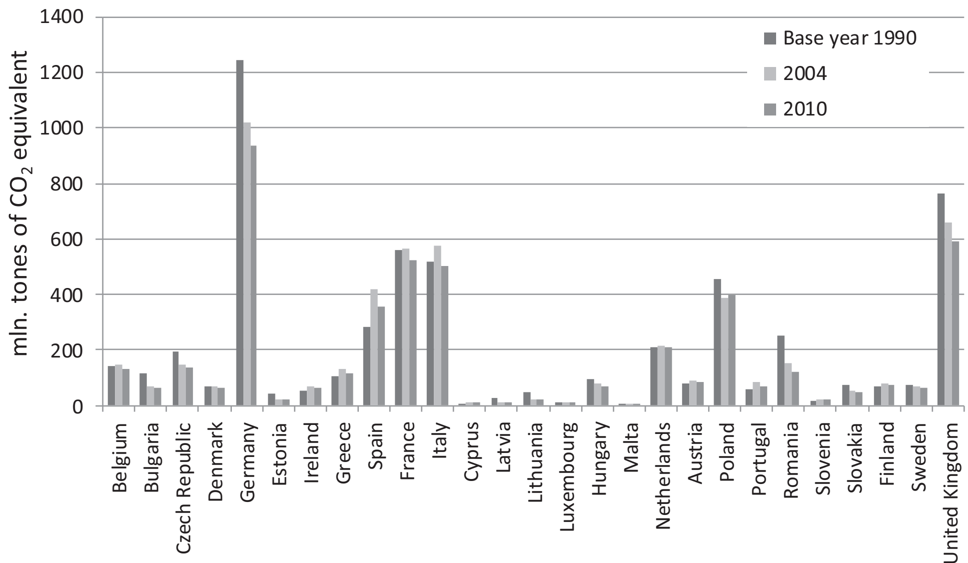


Fig. 16. Emissions of greenhouse gas in Lithuania and EU-27 countries for the base year 1990 and the 2004, 2010 years (million tonnes of CO_2 equivalent).

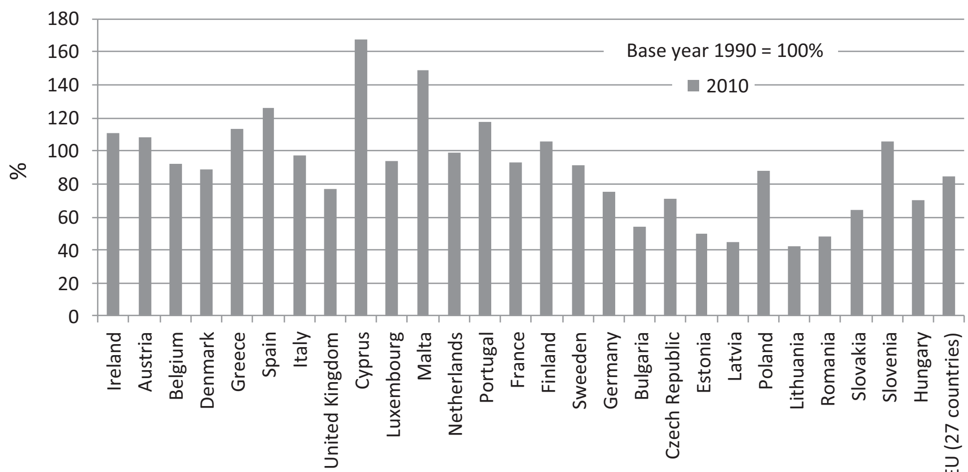


Fig. 17. Greenhouse gas emissions index in Lithuania and EU-27 countries in 2010 (base year 1990 = 100%).

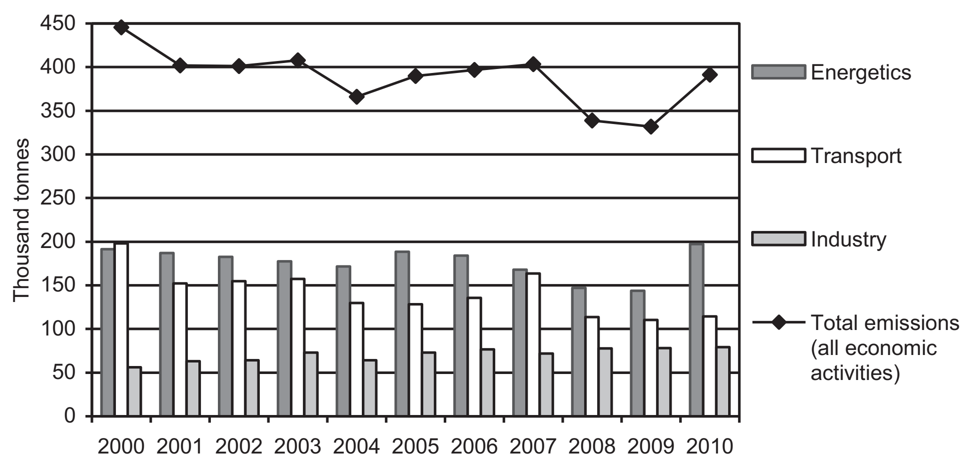


Fig. 18. Emission of air pollutants by economic activities in Lithuania for the 2000–2010.

freely choose the type of energy resources and the sources of their supply (including local production) so that they best meet the state's energy security needs and Lithuanian consumers' interests to procure energy resources at the most favourable prices.

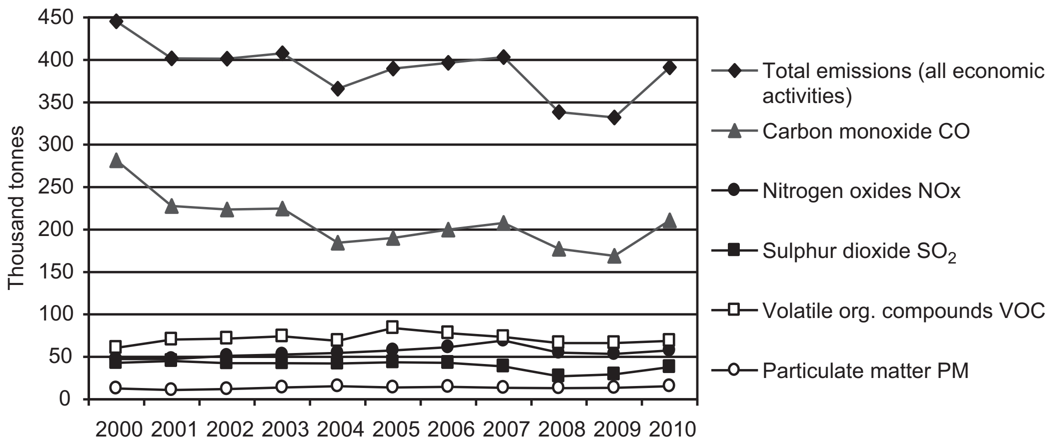


Fig. 19. Composition of air pollutants in total emissions (all economic activities) in 2000–2010 in Lithuania.

Like many other countries in Europe, Lithuania is facing challenges in the energy sector on three main dimensions: **security of energy supply, competitiveness and sustainability** of the energy sector. This situation was determined by historic and political circumstances as well as scarce internal energy resources. Most of energy resources used in Lithuania are imported. After the shutdown of Ignalina NPP, the country is not able to satisfy its internal electricity demand at competitive prices. The Lithuanian electricity network is not connected to the European electricity system and therefore electricity can be imported only from a very limited number of countries.

In order for Lithuania to become a fully-fledged member state of the EU, the **Lithuanian energy sector should be entirely integrated into the European energy system**. The country must have sufficient local capacity to satisfy the internal energy demand and, with regard to energy related questions, should be able to participate and compete in common EU energy markets and effectively cooperate with other countries.

In Lithuanian Energy Strategy are set a number of tasks and major solutions in the fields of electricity, heating, gas, oil, renewable energy sources and improvement of energy efficiency, environment protection and reduction of greenhouse gas emissions.

*In the **electricity energy** sector*, the focus is on the implementation of those strategic projects and solutions which have crucial impact on ensuring the country's energy independence, i.e.

(a) **Full Integration into the European Energy Systems:**
- start-up of the Lithuanian–Polish power link ***LitPol Link 1*** in 2015 and extension of the link in 2020; also the completion of the Lithuania–Poland cross-border power connection (***LitPol Link 2***) which are required for the future synchronous interconnection with the European Continental Network of the European Network of Transmission System Operators for Electricity (ENTSO-E);
- completion of the Lithuanian–Swedish power link ***Nord-Balt*** in 2015;
- development of the liberal Regional Baltic States' electricity market and integration into the Nordic and Continental European Electricity Markets;
- synchronous interconnection of the Lithuanian, Latvian and Estonian electricity transmission systems with the European Continental Network of ENTSO-E.

(b) **Ensuring sufficient competitive local electricity generation capacities** to cover the basic generation demand and domestic energy demand in 2020 (estimated at 12–14 TWh per year) through:
- construction of a new regional nuclear power plant in Visaginas;
- increase of the electricity generation capacity from renewable energy sources.

(c) **Implementation of the 3rd EU Energy Package**[1]:
- unbundling of transmission activities from the supply and other activities;
- conformity of the electricity market, development and management principles with provisions and requirements of the 3rd EU Energy Package.

*The main task in the **heating sector*** is to increase energy efficiency in heat production, distribution and consumption while at the same time shifting from mainly gas-based production towards biomass. The state will support initiatives aimed at increasing the heat consumption efficiency, utilisation of waste energy potential and the use of biomass. By the year 2020 the target for decrease in households' and public buildings' heating consumption is 30–40%. Compared to 2011, it will allow saving annually as much as 2–3 TWh of heat. The district heating will be restructured in compliance with principles of the 3rd EU Energy Package, as well as by ensuring provisions for arrangement of activity of heat production and transmission enterprises substantiated by fair and efficient competition. The transparent activity of heat production and transmission enterprises and their control will ensure heat supply services at the least prices.

In the ***gas sector***, Lithuania will strive in the long run to decrease gas consumption by replacing it with renewable energy sources, while ensuring gas supply alternatives in the short run. To this end, Lithuania will construct a Liquefied Natural Gas (LNG) terminal in Klaipėda, undertake all efforts to build an underground gas storage facility and a Lithuania–Poland gas pipeline linking the country to the EU's gas pipeline networks and markets. The gas market will be liberalised by separating gas supply and gas transmission activities according to the provisions of the 3rd EU energy package.

In the ***oil sector*** the goal is to gradually replace oil products with renewable energy sources and increase competition in the Lithuanian market.

[1] (The 3rd EU energy package includes Regulation (EC) ***No 713/2009*** of the European Parliament and of the Council of 13 July, 2009 establishing an Agency for the Cooperation of Energy Regulators; Regulation (EC) ***No 714/2009*** of the European Parliament and of the Council on conditions for access to the network for cross-border exchanges in electricity; Regulation (EC) ***No 715/2009*** of the European Parliament and of the Council on conditions for access to the natural gas transmission networks; Directive ***2009/72/***EC of the European Parliament and of the Council concerning common rules for the internal market in electricity; Directive ***2009/73/***EC of the European Parliament and of the Council concerning common rules for the internal market in natural gas).

Lithuania will progressively increase the *use of **renewable energy sources*** (RES) in the production of electricity and heating as well as in the transport sector. The state will aim to reach the target of no less than **23%** of renewable energy in final energy consumption, including no less than **20%** of renewable energy in the electricity sector, no less than **60%** in the district heating sector and no less than **10%** in the transport sector. Clear conditions of support to RES will be introduced, giving preference to the most economically and technically feasible solutions of renewable energy.

Considering the ***energy efficiency***, the target is to achieve annual savings of 1.5% of the total final energy consumption in the period through 2020, and in such a way to contribute to the enhancement of Lithuania's energy independence, competitiveness and sustainable development.

Implementation of the initiatives outlined in the Lithuanian Energy Strategy will have a positive ***impact on the environment***, will enable Lithuania not to emit additionally 11 million tonnes of greenhouse gas emissions in CO_2 equivalent before 2020. This would amount up to **46%** of the actual greenhouse gas emissions in 2008.

In 2020 the Lithuanian energy sector will be fully independent of the energy supply from a single source. Electricity demand will be covered by using the new regional nuclear power plant in Visaginas and by increasing production capacity from RES. Stable and diversified gas supply will be ensured after installation of LNG terminal. In addition, Lithuania, having possibilities to import oil and oil products through JSC "Klaipėdos Nafta", will be able to satisfy demand for oil products from diversified sources.

Strategic initiatives that will bring Lithuania's energy independence will cost the government sector 11–13 billion LTL (including the assets of state-owned companies, EU structural funds and international support). Additional 11–14 billion LTL will be attracted from private investors. The investment will yield annual savings of 3–4 billion LTL (3–4% of the Lithuanian GDP), which are currently spent on imported energy resources.

8. Conclusions and options for the future

1. After the integration of Lithuania to the EU in 2004, economy development in 2004–2012 was very variable. In 2004–2008 Lithuanian economy grew rapidly. GDP increased about 1.8 times – from 63 to 112.1 billion LTL (Lithuanian Litas) at current prices and Lithuania was one of the most rapidly developing countries in the EU. The yearly growth rate average of GDP was 7.1%. In 2009 Lithuanian economy declined very much, GDP growth rate in comparison to the previous year decreased to −14.8% (consequences of the financial crisis). From 2009 to 2012 Lithuanian economy slowly recovered and GDP reached the volume before the crisis.
2. GDP per capita at current prices in 2004 in Lithuania was 18.3 thousand LTL and over the period till 2008 (period before the financial crisis) increased about twice to 35.1 thousands LTL. That amounted around 61% of EU-27 average by PPS. During the pick of Lithuanian economy recession in 2009 GDP per capita was reduced to 29.1 thousands LTL and amounted only 55% of EU-27 average. In 2011, GDP per capita reached the level before the crisis.
3. Gross inland fuel and energy consumption in Lithuania for the period 2004–2011 changed in the range 295–392 PJ. For the Lithuanian needs were used the indigenous, renewable and imported energy resources. In 2009 the most part, 29.7% of gross inland consumption depended on nuclear energy, the next were crude oil and petroleum products − 28.7% and natural gas − 25.1%. Indigenous and renewable energy sources consisted of 14.7% of gross inland energy consumption.
4. At the end of 2009, according the requirements of EU, due to the usage of unsafe technologies, the Lithuanian Ignalina NPP was closed and the structure of gross inland fuel and energy consumption in Lithuania changed radically. In 2011 the distribution of gross inland fuel and energy consumption in Lithuania were similar as in 2010 and were as follows: electricity − 7.9%, crude oil and petroleum products − 33.6%, natural gas − 37.3%, coal and coke − 2.9%, indigenous and renewable energy − 18.3%.
5. The main share 68.8% of renewable and indigenous energy resources in 2011 in Lithuania depend on biomass. Energy from chemical processes consisted of 18%, liquid biofuel − 3.3%, hydro-energy − 3.3%, wind power − 3.3% and other sources − 3.3%. About 43.3% of indigenous and renewable energy resources were transformed in CHP and heat plants, 43.2% – consumed in households, 5.6% – in industry and 7.9% – in other sectors.
6. A wider use of renewable energy resources in electricity and heat production and transport enables a reduction in the consumption of imported fossil fuel, especially natural gas and petroleum products. In 2011, firewood, wood and agricultural waste accounted for 86.5% of the total consumption of renewable energy sources in Lithuania, biofuel − 4.4%, hydropower − 3.9%, wind energy − 3.9%, biogas − 1.0%.
7. The share of RES in the total energy consumption in Lithuania for the period 2004–2011 increased from 8.0% to 14.5%. The share of electricity from RES in the total energy production for the period 2004–2009 increased from 2.2% to 4.5% and for the period 2009–2011 – from 4.5% to 23.1%. The share of biofuel in road transport fuel consumption increased from 0.1% in 2004 to 4.4% in 2009 and slightly decreased to 3.7% in 2011.
8. The final energy consumption in Lithuania in 2004–2007 increased 16.5% from 180 to 210 PJ. In 2008 and 2009 (years of the global financial crisis) such consumption decreased respectively to 205 and 192 PJ and in 2010–2011 years – increased to 197–200 PJ. In 2011 oil products comprised 34.1%, heat – 18.5%, electricity − 15.7%, natural gas − 11.3%, firewood and other fuels − 15.5% of final energy consumption.
9. The total energy intensity in Lithuania for the period of 2004–2011 decreased about 1.2 times, from 70 to 58 TOE/LTL million of GDP. Energy intensity in industry on such period decreased also by 1.2 times (from 60 to 50 TOE/LTL million of GDP), in services sector − 1.4 times (from 21 to 15 TOE/LTL million of GDP). Energy intensity in household and transport sectors decreased by 1.2 times, from 22 to 19 TOE/LTL million of GDP.
10. The total emissions of greenhouse gas in 2000–2010 in Lithuania ranged 19,364–25,443 thousand tonnes of CO_2 equivalent. Emissions of greenhouse gas in Lithuanian industry ranged in 2249–6165 thousand tonnes of CO_2 equivalent, in energetics – in 4814–5777 thousand tonnes of CO_2 equivalent and in transport – in 3427–5418 thousand tonnes of CO_2 equivalent. In 2010, the emissions of greenhouse gas in energetics comprised 26.2%, industry − 10.8%, transport − 21.9% and other activities − 41.1% of total greenhouse gas emissions in Lithuania.
11. In 2010 the total greenhouse gas emissions in Lithuania increased by 4.3% compared to 2009 and mainly in public electricity and heat production due to growing gas-based thermal power production. The average of 2008–2010 emissions in Lithuania was 56.3% lower than the base year 1990 level (well below the Kyoto target of −8% for the period 2008–2012).
12. The total emissions of air pollutants of all economic activities in Lithuania from 2000 to 2010 decreased by 12% (from 446 to

391 thousand tonnes). The main part, 50.4% of such emissions in 2010 depended on energetics, 29.3% – for transport and 20.3% – for industry. In energetics and transport sectors 52–72% dominated carbon monoxide emissions, whereas in industry – 55–70% volatile organic compounds.

After the shutdown of Ignalina NPP, Lithuania's energy system became highly dependent on import of electricity and fossil fuels. The fact that differently from many other EU member states Lithuania is isolated from the EU energy systems complicates the situation: there are no electricity and gas interconnections with the Continental Western Europe and, therefore, the country is dependent on the sole external energy supplier. Lithuania has to import more than half of consumed electricity from neighbouring countries, with most of the remainder of electricity and heat generated using gas supplied by a single source.

Currently the Lithuanian energy sector is not fully competitive. The country's energy market, pursuant to the 3rd EU energy package, is being made more competitive through implementation of ownership unbundling in the electricity and gas sectors to boost competition and bring more transparency. In the electricity sector, ownership of electricity generation, distribution and transmission is being unbundled. In the gas sector, ownership of gas transmission and supply is being unbundled.

The energy sector also faces sustainability challenges. Energy intensity per unit of GDP is 2.5 times higher than the EU average. This reveals vast untapped potential in the field of energy efficiency, especially in heating and transport sectors.

Lithuania's dependence on fossil fuels has caused CO_2 emissions to increase, especially after the closure of the Ignalina NPP. This creates additional difficulties for sustainable development of the energy sector.

The **vision of Lithuanian energy sector** is based on three main principles, each being given the highest priority in different periods of the state's Energy Strategy's implementation (**by 2020**, **2020 to 2030** and **2030 to 2050**).

Until 2020, the country's highest priority is energy independence. It will offer an opportunity to freely choose the type of energy resources and the sources of their supply (including local production) so that they best meet the state's energy security needs and Lithuanian consumers' interests to procure energy resources at the most favourable price. The structural changes in the energy-mix through gradual decrease of dependence on fossil fuel and alternatives to a single external energy supplier will ensure the country's energy security and the sustainable development of the energy sector. Energy projects and initiatives outlined in the strategy also form an integrated set which is required in order to achieve Lithuania's energy independence. The implementation of all these strategic projects will help reach 80% of Lithuania's energy security level and allow Lithuania, as an integral part of the EU Baltic Sea Region, to move to another geopolitical space, which is based on the competition of energy market players, equal conditions and transparency.

Energy independence – the possibility of free choice of the type of energy resources and sources of their supply – will be achieved by (a) enhancing competitive local energy generation, including the implementation of the new regional nuclear power plant project; (b) providing alternative supply of energy sources; (c) promoting the development of renewable energy sources and enhancing energy efficiency.

The implementation of strategic projects required for the achievement of energy independence will ensure that in 2020 more than 80% of energy-mix, which is currently being imported from the single supplier, is replaced with a well-balanced structure of energy resources. In 2020, at least half of the required energy will be generated locally (with the focus on nuclear power and renewable energy sources), while the rest of energy will be imported from different sources. New electricity generation capacities as well as electricity and gas connections with EU networks will ensure that internal energy demand is satisfied and allows benefiting from participation in the joint EU energy market.

In the period from **2020 to 2030,** the Strategy aims at **creating a competitive and sustainable energy sector**. Lithuania will continue to increase the share of environment-friendly energy sources in the energy-mix and will further enhance the energy sector infrastructure in order to fully support advancements in renewable energy production. As a result, by 2030 Lithuania will have a competitive and environment-friendly energy sector, with most of the energy produced from renewable energy sources and nuclear energy.

In the period from **2030 to 2050,** the main priority of the strategy is to **further increase the sustainability of the Lithuanian energy sector**. In this period, new breakthrough technologies will be selectively adopted, focusing on the sustainable and environment-friendly energy production and consumption. As a result, by 2050 Lithuania will be independent from imports of fossil fuel and produce its energy only from nuclear energy and renewable energy sources.

The vision, goals and strategic initiatives of the Lithuanian energy sector are in line with the guiding principles of the EU's energy policy – security of energy supply, competitiveness and sustainability, whereas the assurance of Lithuania's energy independence is directly related with the recently growing trend towards the strengthening of the EU external dimension of the EU energy policy.

Political commitments of vital importance for Lithuania facilitating the achievement of Lithuania's energy independence and chances of integration into the European energy system have been adopted at the European Union level.

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